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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G01S 13/74, H04B 1/59

A1

(11) International Publication Number: WO 97/24628

(43) International Publication Date: 10 July 1997 (10.07.97)

(21) International Application Number: PCT/SE96/01760

(22) International Filing Date: 30 December 1996 (30.12.96)

(30) Priority Data:
9600015-3 2 January 1996 (02.01.96) SE

(71) Applicant (*for all designated States except US*): TAGMASTER AB [SE/SE]; Elektrum 410, S-164 40 Kista (SE).

(72) Inventor; and
(75) Inventor/Applicant (*for US only*): GUNNARSSON, Staffan [SE/SE]; Svärdsliljevägen 62, S-165 77 Hässelby (SE).

(74) Agents: ÖRTENBLAD, Bertil et al.; Noréns Patentbyrå AB, P.O. Box 10198, S-100 55 Stockholm (SE).

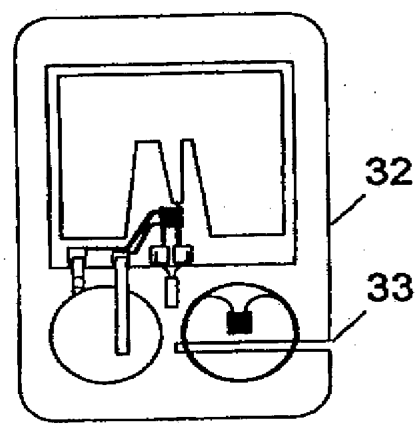
(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.
In English translation (filed in Swedish).

(54) Title: A DEVICE THAT HAS TWO DATA CARRIERS

(57) Abstract

A device having two data carriers for the transfer of information at both low frequencies (Khz, Mhz) and microwave frequencies (Ghz). The invention is characterized in that it comprises a permanently sealed unit in the form of a card which accommodates both a microwave-based first data carrier having a first readable and/or readable and writable register, and an inductive second data carrier having a second register which can be read and/or read and written by means of induction at low frequencies, wherein the two data carriers are separated physically from one another.



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A device that has two data carriers

The present invention relates to a combined low frequency (kHz, MHz) and microwave device (GHz) that has two separate data carriers which function in different frequency ranges and which are incorporated permanently in a card. In one embodiment, the low frequency data carrier has been programmed with data from the high frequency data carrier.

One problem with microwave-based (GHz) identification systems is their high cost in comparison with identification systems that operate at low frequencies. Microwave technology permits relatively long ranges, several metres, between data carrier and communications unit, but entail additional costs in the communications unit owing to the inclusion of more expensive and more numerous components than in the case of low frequency systems (kHz, MHz), which usually operate in accordance with induction techniques. Such so-called inductive systems have a typical range of up to half a metre.

Integration of the two techniques in one and the same data carrier is problematic, because the many components require the application of totally different techniques. The differences in, *inter alia*, communications methods, such as clock frequencies, modulation, etc., connection techniques, such as microstrip conductors as opposed to wound coils, etc., and power supply, such as battery power as opposed to electromagnetic energy transfer have, even though technically possible to achieve, entailed costs that have made it difficult commercially to use one and the same data carrier for the two transmission methods.

The fact that a combined technique has long been desirable is borne out by Swedish Patent Specification 9001729-4, priority date 14 May 1990, and U.S. Patent Specification 5,426,667,

priority date 17 June 1993, both of which describe a data carrier that can communicate with both microwaves and inductively. The technical solutions, however, are relatively complicated. In certain embodiments described in the aforesaid patent specifications, the inductive part communicates via the microwave part, for instance by virtue of the inductive part being an insert unit in the microwave part and/or by virtue of the microwave part being an insert unit in the inductive part of the data carrier.

A very important factor with respect to the invention is that in recent times (1995) inductive data carriers have been produced in such large series as to drastically lower their costs. A complete inductive data carrier including microchip, antenna coil and possibly detuning capacitor and encapsulation can be produced at present for about one U.S. dollar (USD 1.00) and thus in the same size as a magnetic card, as compared with several times this price for a microwave data carrier. Only some years ago, the cost of an inductive data carrier was in the region of what a microwave data carrier costs today, and consequently there was then justification in attempting to use common circuits in an integrated data carrier.

Another problem is that the data carrier of a microwave system is normally battery powered and that such systems cannot be read if the battery runs down. Consequently, it would be an advantage if at least a part of the code that was readable via the microwaves prior to the battery running down could also be read inductively after the microwave data carrier had failed.

A third problem is that in order for a microwave-based system to obtain its high range, it is necessary to enable antennas in the data carrier to be aligned or directed, which makes reading difficult when manually handling the data carrier, which should

preferably be readable from any chosen direction, both from the front and from the rear.

A fourth problem is that microwave-based data carriers are normally difficult to accommodate in a unit of credit card size without disturbing their antenna functions. This applies in particular when the data carriers shall operate within a good range in the lower part of the microwave region, e.g. at 2.45 Ghz, and therefore present a highly effective antenna area. The installation of further functions in the card therefore becomes highly problematic.

In some instances, the microwave parts of a data carrier include metal surfaces that are liable to short-circuit inductive fields. It is generally known that inductive data carriers are unable to function smoothly on metal surfaces, because induced eddy currents considerably shorten the range of such data carriers.

In some applications, the risk of forging the code of the unit presents a further problem. If the unit contains two separate registers, it is particularly important that one register cannot be replaced with another, since this would confuse a superordinate system.

Accordingly, the present invention relates to a device having two data carriers for transmitting information at both low frequencies (Khz, Mhz) and microwave frequencies (Ghz). The device is characterized in that it is comprised of a permanently sealed or closed unit in the form of a card which incorporates both a microwave-based first data carrier having a first readable and/or readable and writable register, and an inductive second data carrier having a second register which is readable and/or readable and writable at low frequencies by means of induction;

and in that said two data carriers are physically separated from one another.

The present invention thus solves the aforesaid problems by virtue of one and the same permanently sealed unit incorporating a microwave-based first data carrier having a first readable and/or readable and writable register, and also a permanently mounted and inductive second data carrier having a second register which is inductively readable and/or inductively readable and writable at low frequencies. The unit may have the form of a thin card, for instance.

The integration problem is solved primarily by the fact that the inductive data carrier is in no way connected to the microwave-based data carrier, so that this latter carrier may be a mass-produced unit. Thus, the data code that can be read from respective data carriers is stored in physically separated registers.

The solution to the problem of cost is also supported by the fact that cheap inductive communication units can be used in the majority of communications points, such as doorway passage controls, while the more expensive microwave technology is applied in places where a long range is required, e.g. in the case of vehicle garage access. Thus, both the inductive and the microwave-based communications units can be included in the same passage control system, for instance in hotels, office complexes, industrial buildings, hospitals, shopping malls, distribution centers or the like.

The microwave data carrier may conveniently be a reflecting type carrier, i.e. of the kind in which no fresh energy is delivered to the incident signal upon reflection of the read information by the data carrier. Data is delivered to a communications unit by virtue of the reflection of information sidebands to a microwave

signal incoming from the communications unit. However, the microwave data carrier will conveniently have a built-in battery for memory backup and for operating low-frequency data clock circuits for data modulation. This enables the desired long range to be obtained even with low radiated microwave power from the communications unit.

The inductive data carrier may conveniently be of the so-called passive type, i.e. internal clocking and data modulation of the radiant low frequency field is effected by using field energy in a known manner for powering and clocking the electronics of the inductive data carrier, therewith obviating the need of a battery to power the function of the inductive data carrier.

Thus, the problem relating to the difficulty of reading the data carrier when its battery has run down has been solved by the fact that the battery-free inductive data carrier can still be read by applying power from the inductive field.

There is thus provided separate integrated circuits of which one circuit communicates via microwave technology (Ghz) and the other circuit communicates via low frequency technology (Mhz, Khz).

In one particular embodiment, the low-frequency data carrier is writable, so as to enable data to be transferred from the memory register of the microwave-based data carrier to the memory register of the inductive data carrier through the medium of at least one external read/write unit.

Since data reading at low frequencies is effected without requiring the battery of the microwave-based data carrier to function, the identity of the unit can be established without needing to use cross-reference lists. This is also an advantage in other respects, even during normal operation, because the

information read from the unit in different parts of the system, both low frequency and high frequency parts, need not be compared with different code lists in order to determine the identity of the unit.

Thus, the need of cross-reference lists is avoided when at least essentially the same data has been written pair-wise into the two data carriers included in each card, so that the card identity is immediately evident irrespective of whether it is the card-carried inductive data carrier or the card-carried microwave-based data carrier that is read. In this regard, it may be an advantage that the data written into the microwave data carrier is at least partially the same as the data written into the inductive data carrier, since a saving in cost is made when only one data carrier, in this case the microwave data carrier, is writable and the other carrier, in this case the inductive data carrier, is a read only carrier. Naturally, the system will also function in the reverse case, i.e. when the preprogrammed code of the microwave data carrier has been written into the inductive data carrier.

A system which includes cross-reference lists in the communications units and/or in the central unit may also be advantageous, since this will enable additional inexpensive read-only technology to be used both for the microwave data carriers and for the inductive data carriers.

The problem of reading the data carrier from different directions is solved by enabling the inductive part to communicate from different directions by virtue of its antenna not having a directional effect, this being achieved because of the smallness of the antenna in relation to wavelengths. In one particular embodiment which includes a patch antenna and an earth plane of

a size similar to that of the antenna, the data carrier can also be read from different directions also with microwaves.

The problem of accommodating the combined function in a unit of credit card size, although slightly thicker in some embodiments, is solved by using double sideband modulation in the microwave part of the data carrier, therewith requiring fewer microwave circuits and also requiring a smaller surface area than when a sideband suppression circuits shall be included. For instance, a construction comprising space-consuming power dividers, phase-shifting circuits, double modulation diodes and high internal clock frequencies is avoided. Thus, in normal cases, the micro-wave-based data carrier will deliver symmetric information sidebands on both sides of an incoming microwave signal from a unit illuminating communications unit.

Further space for the inductive data carrier is created by providing the microwave-based data carrier with a patch antenna which has an earth plane that is not appreciably larger than the patch antenna itself. For instance, if the unit operates at 2.45 Ghz and the relative dielectric constant of the patch antenna is about three, this means that the side of the patch antenna, one-half wave length long, will be about four centimeters. Consequently, in order to accommodate the air-wrapped antenna coil of the inductive data carrier with a defensible area adjacent the patch antenna, or altlernatively around said patch antenna, the diameter of the earth plane should not therefore be appreciably greater than the diameter of the microwave antenna.

An earth plane of about 1.5 times the diameter of the patch antenna will, in the majority of applications, provide the antenna with an acceptable directional effect, without needing to provide a separate reflection plane.

The problem of interference-free communication with respect to the inductive data carrier has been solved by designing the earth plane and/or a possible reflection plane in the microwave-based data carrier in a manner such as to prevent the formation of induction currents that are able to disturb the inductive function. As before mentioned, this is achieved by designing the microwave antenna as a patch antenna with a small earth plane, or alternatively providing a rearwardly lying reflection plane with at least one current breaking slot. In the former case, i.e. in the absence of a reflection plane and with a patch antenna and earth plane of mutually similar size, the data carrier can be read from different directions, both from the front and from the rear, also via the microwaves.

If the antenna of the inductive data carrier surrounds the patch antenna in the aforedescribed manner, it is necessary to prevent the occurrence of eddy currents in said antenna and in its earth plane, e.g. with the aid of narrow slots optionally bridged by capacitors which are conductive for microwave frequencies but highly impeding at low frequencies.

The problem concerning the possible substitution of one register, e.g. the inductive data carrier, in the unit with another is prevented from arising because the data carrier is permanently sealed so that no unit can be changed without great difficulty. An acceptable sealing level is achieved, by sealing the front piece and back piece with a modern adhesive, for instance a type of adhesive whose adherence increases with age.

The invention will now be described with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings, in which

- Fig. 1 illustrates a system using combined technology;
- Fig. 2 illustrates a known technique of microwave identification;
- Fig. 3 illustrates a known technique of low frequency identification;
- Fig. 4 illustrates a microwave data carrier without microwave reflection planes and with side-mounted low-frequency data carriers;
- Fig. 5 illustrates a microwave data carrier that includes a slotted microwave reflection plane and with side-mounted low-frequency data carriers;
- Fig. 6 illustrates a microwave-based data carrier having a microwave reflection plane, with slots provided in said plane and in the microwave antenna and in its earth plane, and including surrounding low-frequency data carriers; and
- Fig. 7 illustrates a unit of the aforesaid kind in three projections.

Fig. 1 illustrates a system for controlling the passage of persons and vehicles with the aid of the present combined technology. A superordinate centre 1 is connected to the low-frequency communications units 2 and 3 and to the microwave-based communications unit 4.

One and the same card 5 can be used conveniently for the access of vehicles to enclosed vehicle parking facilities and thereafter used to afford entry through different doors in the building. Because the short-range inductive communications unit 2, 3 are much cheaper than the long-range unit 4, the system has a very good total economy, despite the card 5 containing a low frequency data carrier in addition to the microwave data carrier.

A short range is often of less significance with regard to doors, although range is utmost important with regard to vehicle access,

since otherwise precision manoeuvering of a vehicle, opening of a vehicle window and extending of an arm would result in a great deal of discomfort and also in vehicle queuing.

Fig. 2 illustrates a typical microwave system in which the data carrier delivers double and symmetrical information sidebands, i.e. on both sides of an incident carrier wave. A communications unit 9 having a microwave oscillator 10 of, e.g., 2.45 Ghz delivers the signal F to the antenna 12 of the data carrier, via an amplifier 11, where the signal is captured, modulated, and re-reflected as the information sideband F +/- f to the communications unit signal mixer 13 and decoding circuits 15, wherein the code from a register 14 in the data carrier is reconstructed. The data carrier may have a resonance element 16 for its internal clocking and the clocking circuits of the data carrier may be powered by a built-in battery 17.

The double sideband modulation is shown schematically in the coordinate system to the right of Fig. 2. An alternative modulation should have been to eliminate one of the sidebands in the data carrier, although this would then require space for accommodating the necessary phase-shifting circuits, etc., in accordance with known techniques. Suppression of one sideband in the communication unit or in the data carrier is totally necessary in a microwave system for avoiding zero settings in space, i.e. blind zones.

Fig. 3 illustrates a communications unit 20 which operates with induction at low frequency in accordance with known techniques. An oscillator 21, at e.g. 125 Khz, generates in the loop antenna 23, via the amplifier 22, an electromagnetic field which is captured by another loop antenna 24 in the data carrier. T'e register circuit 25 of the data carrier changes the impedance across the coil 24 in accordance with a pattern corresponding to

register data, this change being coupled to the transmitter coil 23 by induction, so that the voltage across the coil will increase and decrease in time with the data. These changes are captured in the receiver amplifier 26 and decoder circuits 27 of the communications unit 20 for reconstruction of the data from the register 25 of the inductive data carrier.

A greater range can be obtained, by placing a capacitor 28 across the data carrier antenna coil 24, and by tuning the coil 24 and the capacitor 28 to the illuminating frequency, e.g. 125 Khz.

No battery is required in the inductive data carrier, and the carrier takes its energy from the voltage induced in the coil 24, in a known manner.

Shown at the top of the coordinate system illustrated to the right in fig. 3 is the voltage across the coil 23 of the communications unit when no data carrier is located in the vicinity of the coil, while shown at the bottom of the coordinate system is the same voltage when a data carrier located in the field loads the field by induction in accordance with the aforedescribed and in accordance with a pattern that represents the read data.

Figs. 4-7 illustrate different embodiments of the invention in which the coils all lie in plane with the microwave antenna 30 and its earth plane, either to one side of the microwave antenna (Figs. 4, 5, 7) or surrounding said antenna (Fig. 6). The microwave-based data carrier having the aforesaid microwave antenna 30 is supported by the battery 17 and the resonance element 16 in the manner described above.

In the Fig. 4 embodiment, the low-frequency data carrier and its register-equipped integrated circuit 25 and coil 24 are located by the side of the microwave antenna. Although not seen in Fig.